Optical and electrochemical investigation of the interactions of functionalised nanoparticles with suspended lipid membranes

The promises (and in some cases applications or ongoing developments) of nanoparticle drug delivery systems over the past three decades have led to a large amount of scholarly work on the interactions of nanoparticles with model lipid membranes. Even though model lipid membranes are a crude estimate of biological membranes as they lack many of their essential features (e.g. transmembrane proteins, proteoglycans, active processes), this very lack of complexity enables to dissect fundamental phenomena in a reductionist approach that enables comparison with theoretical predictions. Indeed, published work includes both experimental, and, especially in the last decade, computational work. Yet, the variability of the membrane models, experimental approaches and nanomaterials used, the lack of quantitative measurements in most studies, and the often limited evaluation of the predictive value of the theoretical and computational models have resulted in a rather confused picture.[1] With this PhD project, we aim to bring some clarity to some of those open questions. To reach this aim, we will combine optical and electrochemical techniques[2,3] to systematically investigate the interactions of functionalised nanoparticles[4–6] with suspended lipid membranes as a function of particle diameter, surface properties, lipid composition and phase. The project, at the interface between chemistry and biophysics, will offer an interdisciplinary training experience to a curious and motivated student.

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Funding: the supervisory team is looking for a candidate that they would support to compete for an "allocation doctorale de recherche" (PhD student stipend from French government) from the école doctorale Gallilée (https://ed-galilee.univ-paris13.fr/). There are no conditions of nationality but you must have obtained (or be on course to obtain this academic year) a master in a relevant discipline. If you are interested, you must contact Laurence Motte (laurence.motte-torcheux@univ-paris13.fr) as soon as possible and on the 25th May at the latest with a CV and a motivation letter.

1. Lévy, R. & Erden, Y. J. The long life of unicorns. *Precision Nanomedicine* **3**, 677–684 (2020).
2. Fadda, G. C., Lairez, D., Guennouni, Z. & Koutsioubas, A. Peptide Pores in Lipid Bilayers: Voltage Facilitation Pleads for a Revised Model. *PHYSICAL REVIEW LETTERS* **111**, (2013).
3. Fadda, G. C., Lairez, D. & Zalczer, G. Fluctuations of Ionic Current Through Lipid Bilayers at the Onset of Peptide Attacks and Pore Formation. *PHYSICAL REVIEW LETTERS* **103**, (2009).
4. Benyettou, F., Guenin, E., Lalatonne, Y. & Motte, L. Microwave assisted nanoparticle surface functionalization. *Nanotechnology* **22**, 055102 (2011).
5. Colangelo, E. *et al.* Computational and experimental investigation of the structure of peptide monolayers on gold nanoparticles. *Langmuir* **33**, 438–449 (2016).
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